Q8
p248
Q=?
m = 0.565kg
T_f=20ºC
T_i = 100ºC
c= 450 J/kgºC
Q=mc(Tf-Ti) = 0.565x450x(20-100)=-20,340.0
-20 kJ

b) Big Idea
Heat given off by the metal = heat gained by the water
$-Q_{metal} = Q_{water}$

watch! don't forget the negative sign for the lost heat

- (-20,340.0) = m 4180 (20-0)
m = 20,340.0/(4180x20)=0.2433 kg = 0.24kg

Notes for today:
Thermal equilibrium
If you put two objects in thermal contact (so that heat flows from the hot object to the cold object) the heat lost by one = heat gained by another
$-Q_A = Q_B$

$-m_A c_A (\Delta T_A) = m_B c_B (\Delta T_B)$

The heat flows until they are in thermal equilibrium (fancy word for same temperature), T_E, the equilibrium temperature.

$$-m_A c_A (T_E - T_{Ai}) = m_B c_B (T_E - T_{Bi})$$

eg. You have 67.5 g of iron (c=450J/kg^{o}C) in boiling water. You take it out of the boiling water and put it in 150 g of water(c=4180J/kg^{o}C) at 20.0^{o}C.

a) what is the equilibrium temperature of the water and iron?

b) you do the same experiment with 73.2g of an unknown metal in 150 g of water at 20.0^{o}C and the equilibrium temperature is 29.0^{o}C. What is the specific heat capacity of the unknown metal?

p252 Q9-12, CR1.1-1.4

read lab p34 online lab manual

$P_i = P_f \quad m_1 v = 2m_1 x + m_2 y$

$E_k = E_{k_f} \quad \frac{1}{2} m_1 v^2 = \frac{1}{2} 2m_1 x^2 + \frac{1}{2} m_2 y^2$

$v = x + y \rightarrow y = v - 2x$

$$v = 2x + y \quad \rightarrow y = v - 2x$$

$$v^2 = 2x^2 + y^2$$

$$v^2 = 2x^2 + (v - 2x)^2$$

$$v^2 = 2x^2 + v^2 - 4xv + 4x^2$$

$$0 = 2x^2 - 4xv + 4x^2$$

$$6x^2 = 4xv$$

$$x = \frac{4}{6}v = \frac{2}{3}v$$

$$J = Nm = kg\,m^2/s^2$$

$$\frac{J \cdot s}{kg\,m} \qquad \frac{kg\,m^2 \cdot s}{s^2\,kg\,m} = \frac{m}{s}$$

Go over Q8 on p 248
Notes Thermal Equilibrium
Hand back test
prep lab?

Q8 565g iron from boiling water to 20ºC.

a) Q=?

b) mass of water going from 0 to 20ºC?

a) m = 0.565kg c=450 J/kgºC T_i = 100ºC
T_f=20ºC
$Q=mc(T_f-T_i)$
= 0.565x450x(20-100)=-20,340.0
20kJ are given off by the metal

b) Big Idea is that the heat lost by the metal goes into the water.
$-Q_{metal} = Q_{water}$
↑
watch the negative sign

- (-20 340J) = m 4180 J/kgºC (20ºC - 0ºC)
m= 20340/(4180x20)=0.2433
0.24kg of water

Notes:
Thermal Equilibrium
When you put two objects in thermal contact (put a hot metal into cold water) the heat

flows from hot to cold until the are both at the same temperature, thermal equilibrium. T_E is the equilibrium temperature.

$-Q_A = Q_B$
if there are no changes in state
$-m_A c_A(T_{Af}-T_{Ai}) = m_B c_B(T_{Bf}-T_{Bi})$
continues until $T_f = T_E$ for both

$$-m_A c_A(T_E-T_{Ai}) = m_B c_B(T_E-T_{Bi})$$

eg. In the lab next class, you will put 67.5 g of metal at 100ºC into 150 g of water at 20.0ºC. (c_{water}=4180 J/kgºC)

a) what is the specific heat of the unknown metal?

b) if the metal was iron (c_{iron}=450 J/kgºC) what would be the equilibrium temperature?

p252 practice problems 9-12 CR 1.1-1.4
read lab p34 on the online lab manual.

$$mx1 + 3m(-1) = mx + 3my$$

$$-y = x + 3y \quad y = \frac{-2-x}{3}$$

$$-2 = x + 3y \qquad y = \frac{-2-x}{3}$$

$$\frac{1}{2}m1^2 + \frac{1}{2}3m(-1)^2 = \frac{1}{2}4x^2 + \frac{1}{2}3my^2$$

$$4 = x^2 + 3y^2$$

$$4 = x^2 + 3\left(\frac{-2-x}{3}\right)^2$$

$$4 = x^2 + 3\left(\frac{4+4x+x^2}{9}\right)$$

$$12 = 3x^2 + 4 + 4x + x^2$$

$$0 = 4x^2 + 4x - 8$$

$$0 = x^2 + x - 2$$

$$0 = (x+2)(x-1)$$

$$x = -2 \text{ km/s}$$